PATENT

#8 Appeal Brief
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Kathy Dixon

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Chen et al. — Group Art Unit 2814

Variable Trigger Voltage Silicon Controlled Rectifier — Examiner: D. Farahani

U.S. Serial No. 10/006,269 — Filed: December 4, 2001

Attorney Doc. No.: 67,200-537

APPELLANTS' BRIEF

Assistant Commissioner for Patents
Washington, D.C. 20231

REAL PARTY IN INTEREST

The real party in interest herein is Taiwan Semiconductor Manufacturing co., Ltd., to whom the entire right and interest of the subject patent application have been assigned.

RELATED APPEALS AND INTERFERENCES

Appellants, Assignee, and the undersigned are not aware of any related appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in this Appeal.

STATUS OF CLAIMS

Claims 1 through 18, 21 through 23, and 26 through 39 stand finally rejected under 35 U.S.C. § 102(e) as being unpatentable over Yu (U.S. Patent No. 6,353,237), hereafter "Yu."

Claims 19, 20, 24, and 25 stand finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Yu.

No claims have been allowed or indicated to be allowable.

Claims 1-39 are on appeal.

STATUS OF AMENDMENTS

The reply under 37 CFR 1.116 filed on February 03, 2003 has been refused entry because the examiner did not consider the arguments therein to be persuasive of the impropriety of the subject rejections.

SUMMARY OF INVENTION

The invention is directed to an on-chip silicon controlled rectifier (SCR) electrostatic discharge (ESD) protection device that is characterized by a low trigger threshold voltage effected without the integration of an auxiliary triggering device. The structure is a SCR device wherein the triggering mechanism is a reach-through assisted conduction, to wit collector voltage "reaches through" the base to the emitter in at least one of the pair of bipolar transistors making up the SCR device. Reach-through is understood to be effectuated by expansion of the collector-junction depletion region width across the base and may be influenced by various combinations of device geometries and dimensions, doping concentrations and gradients, and substrate and dopant selection.

Independent claim 1 claims the present invention as a device comprising a pair of complementary bipolar transistors fabricated such that a ***reach-through effect across the base of at least one of the complementary bipolar transistors causes triggering*** of the device. Independent claim 7 similarly recites first and second transistors and an avalanche junction wherein one of the first and second transistors is characterized by ***attaining a reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage.*** Independent claim 26 similarly recites a structure of lightly and heavily doped regions of first and second conductivity types and an avalanche junction wherein a ***reach-through effect occurs prior to an avalanche junction breakdown across the avalanche junction***.

ISSUES

Whether claims 1 through 18, 21 through 23, and 26 through 39 were properly rejected under 35 U.S.C. § 102(e) as being unpatentable over Yu.

Whether claims 19, 20, 24, and 25 were properly rejected under 35 U.S.C. § 103(a) as being unpatentable over Yu.

GROUPING OF CLAIMS

The claims involved in this appeal are not considered to be separately patentable over the prior art of record.

ARGUMENTS

The rejection of claims 1 through 18, 21 through 23, and 26 through 39 is in error because it is based upon an unsupportable interpretation of the teachings of Yu and the consequent unsupportable equating of the elements of Yu to those of the present invention. As explained below, Yu when properly interpreted and understood clearly fails to teach or disclose the recited elements and limitations found in Appellants' claims, and therefore Yu cannot possibly anticipate claims 1 through 18, 21 through 23, and 26 through 39; and, for the same reasons, Yu cannot provide the basis for the obviousness rejections levied against claims 19, 20,

24, and 25 since Yu does not teach or disclose various recited elements and limitations of those claims necessary to support an obviousness type rejection.

Yu teaches a ESD protection device. The ESD protection device includes a SCR 4 comprising a pair of bipolar junction transistors 40,41. In addition to the bipolar junction transistors, a structure separate and distinct from the SCR bipolar transistors comprising an N-type doped region 36 is laid out in the P-type semiconductor layer 30 so as to establish a junction 37 (col. 3, lines 27-34; Figs. 3 and 5). This N-type doped region and P-type semiconductor layer serve as the cathode and anode of a diode 6 (col. 3, line 67 through col. 4, line 2). Yu teaches that in operation the diode junction breaks down at substantially the breakdown voltage of the diode. This diode junction breakdown current then turns on transistor 41 thus triggering the SCR 4.

Independent claim 1 claims the present invention as a device comprising a pair of complementary bipolar transistors fabricated *such that a <u>reach-through effect across the base of at least one of the complementary bipolar transistors</u> causes triggering of the device.* Independent claim 7 similarly recites first and second transistors and an avalanche junction wherein *<u>one of the first and second transistors</u> is characterized by attaining a <u>reach-through</u> voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage.* Independent claim 26 similarly recites a structure of lightly and heavily doped regions of first and second conductivity types and an avalanche junction *wherein a <u>reach-through</u> effect occurs prior to an avalanche junction breakdown across the avalanche junction.*

It is clear that Yu teaches a separate diode structure whereas Appellants' claims recite SCR bipolar transistor structure. Yu teaches diode junction breakdown of the separate diode structure, whereas Appellants' claims recite break-through effects across the base of SCR bipolar transistor structure. Each and every element as set forth in the claims <u>is not</u> found, either expressly or inherently, in Yu.

The Office Action dated December 03, 2002 incorrectly alleges that the Appellants admit "that in the claimed invention the SCR is triggered in accordance with break down across the junction of [base]." The Examiner similarly alleges that the Appellants adopt a definition of reach-through effect that is equivalent to PN junction breakdown. The subject Office Action then

further incorrectly equates the *PN junction breakdown* triggering effect disclosed in Yu (column 1, lines 46-67) to the *reach-through* triggering effect claimed by Appellants. The Examiner is simply mistaken in the allegation and conclusion. Any explanation or definition offered by Appellants in the various responses and specification are completely consistent in distinguishing reach-through from breakdown. It is an improper characterization, and one not supported by the specification and prosecution record, that the PN junction breakdown discussed in Yu is the same as reach-through effect according to Appellants' claims. Appellants can only surmise that the Examiner has misread the portions relied upon in support of such allegations.

Appellants' believe that the portion of Appellants' September 23, 2002 response relied upon as discussed above is as follows:

> In fact, Yu teaches a separate diode structure apart from the transistor structures of the SCR that is completely absent from the claims of the present invention and which operates to trigger the device in accordance with the breakdown across the junction thereof. The present invention SCR is triggered by reach-through across the base of at least one of the transistor structures thereof.

And, Appellants' believe the portion of Appellants' specification relied upon as discussed above is as follows:

> In accordance with these and other objects and advantages, the present invention comprises an on-chip SCR ESD protection device that is characterized by a low trigger threshold voltage effected without the integration of an auxiliary triggering device. The structure is a SCR device wherein the triggering mechanism is a reach-through assisted conduction. Reach-through assisted conduction as the term may be used herein is understood to mean SCR triggering caused by, attributed or due to, collector voltage reaching through the base to the emitter in at least one of the pair of bipolar transistors making up the SCR device. Reach-through is understood to be effectuated by expansion of the collector-junction depletion region width across the base an [sic] may be influenced by various combinations of device geometries and dimensions, doping concentrations and gradients, and substrate and dopant selection.

It is clear from these portions of the prosecution record and specification alone, and even clearer when taken in conjunction with the entire specification, prosecution record and claims, that the rejections are unsupportable in as much as they rely upon erroneous interpretations and characterizations of Appellants' invention elements and limitations and subsequent erroneous

conclusions by the Examiner in equating the teachings of Yu to the Appellants' invention. Quite simply, it appears to be error in interpretation compounded by error in application.

Throughout the Appellants' specification and as called out in the Appellants' various response, the claimed invention comprises a pair of complementary bipolar transistors fabricated *such that a reach-through effect across the base of at least one of the complementary bipolar transistors causes triggering of the device.* Additionally, Appellants specifically point out that in the silicon controlled rectifier of claims 7 and 26 *a reach-through effect occurs prior to an avalanche junction breakdown across the avalanche junction.* It is erroneous that the Examiner equates the reach-through triggering effect of Appellants' invention to the PN junction breakdown triggering effect disclosed in Yu. Reach-through is specifically distinguished from junction breakdown throughout the specification and specifically in claims 7 and 26 which state *"wherein one of the . . . transistors is characterized by attaining a reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage"* and "*a reach-through effect . . . occurs prior to an avalanche junction breakdown across the avalanche junction*", respectively. Therefore, in addition to the failure by Yu to teach each and every element as set forth in the claims 1 through 18, 21 through 23, and 26 through 39, Yu, in fact, at column 1, lines 46-67 teaches away from the Appellants' invention in as much as it teaches a PN junction breakdown effect that causes SCR triggering, *which is the very triggering effect that the Appellants' invention avoids* by the break-through effect triggering claimed. Therefore, Yu fails to provide the requisite motivation for one skilled in the art to combine the teachings of Yu with other prior art in support of any obviousness type rejections. Hence, the Examiners obviousness type rejections of claims 19, 20, 24, and 25 fails to establish even a threshold prima-facie case of obviousness let alone a sustainable obviousness rejection.

SUMMARY

The present invention SCR is triggered by **reach-through** across the **base of** at least **one of the SCR transistors** whereas the SCR taught by Yu is triggered by **breakdown** across the **junction** of a distinct **diode** structure that is **not a part of one of the SCR transistors.**

Reach-through of a base of a SCR transistor of the present invention is not equal to nor can it be equated to the breakdown of the separate diode of Yu. These differences are adequately portrayed in the claims and specification as originally presented and have not been contradicted by any of the Appellants' prosecution record. It is erroneous that the Office Action equates the structures and effects claimed by Appellants to the structures and effects taught by Yu. The Examiner has not established that Yu discloses each and every element of the Appellants' invention which is of course a requirement of any anticipation type rejection under 35 USC § 120(e). The Examiner has not extablished a prima-facie case of obviousness.

Appellants respectfully submit that the rejection of claims 1 through 18, 21 through 23, and 26 through 39 under 35 U.S.C. § 102(e) is in error for the reasons set forth above.

Appellants respectfully submit that the rejection of claims 19, 20, 24, and 25 under 35 U.S.C. § 103(a) is in error for the reasons set forth above.

Therefore, Appellants respectfully request that the Board reverse such rejections.

Respectfully submitted,

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ATTACHMENT TO APPEAL BRIEF – USSN 10/006,269

REJECTED CLAIMS SUBJECT TO APPEAL

1. An SCR voltage transient protection device comprising a pair of complementary bipolar transistors each having a respective base, emitter and collector, said SCR fabricated such that a reach-through effect across the base of at least one of the complementary bipolar transistors causes triggering of the device.

2. The device as claimed in claim 1 comprising a lateral SCR.

3. The device as claimed in claim 1 comprising a layered SCR.

4. The device as claimed in claim 1 wherein the reach-through effect occurs across the base of the one of the pair of complementary bipolar transistors that is of a pnp type.

5. The device as claimed in claim 1 wherein the reach-through effect occurs across the base of the one of the pair of complementary bipolar transistors that is of a npn type.

6. The device as claimed in claim 1 fabricated using a CMOS compatible process.

7. A silicon controlled rectifier device comprising:

a first lightly doped region having a first conductivity type formed in a second lightly doped region having a second conductivity type;

a first heavily doped region having said first conductivity type formed in said second lightly doped region;

a second heavily doped region having said second conductivity type formed in said first lightly doped region;

said second heavily doped region, said first lightly doped region and said second lightly doped region forming an emitter, a base and a collector, respectively, of a first transistor;

said first heavily doped region, said second lightly doped region and said first lightly doped region forming an emitter, a base and a collector, respectively, of a second transistor;

an avalanche junction formed at the interface of the first and second lightly doped regions having an avalanche junction breakdown voltage; and,

wherein one of the first and second transistors is characterized by attaining a reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage.

8. A silicon controlled rectifier device as claimed in claim 7 comprising a lateral device.

9. A silicon controlled rectifier device as claimed in claim 7 comprising a layered device.

10. The device as claimed in claim 7 wherein the one of the first and second transistors that attains its reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage comprises the first transistor.

11. The device as claimed in claim 10 wherein the first transistor comprises a pnp type transistor.

12. The device as claimed in claim 10 wherein the first transistor comprises a npn type transistor.

13. The device as claimed in claim 7 wherein the one of the first and second transistors that attains its reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage comprises the second transistor.

14. The device as claimed in claim 13 wherein the second transistor comprises a pnp type transistor.

15. The device as claimed in claim 13 wherein the second transistor comprises a npn type transistor.

16. The device as claimed in claim 8 wherein the one of the first and second transistors that attains its reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage comprises the first transistor.

17. The device as claimed in claim 16 wherein the first transistor comprises a pnp type transistor.

18. The device as claimed in claim 16 wherein the first transistor comprises a npn type transistor.

19. The device as claimed in claim 17 wherein the base of the first transistor is substantially within the range of 0.0005 mm to 0.05 mm.

20. The device as claimed in claim 18 wherein the base of the first transistor is substantially within the range of 0.0005 mm to 0.05 mm.

21. The device as claimed in claim 8 wherein the one of the first and second transistors that attains its reach-through voltage prior to the avalanche junction attaining the avalanche junction breakdown voltage comprises the second transistor.

22. The device as claimed in claim 21 wherein the second transistor comprises a pnp type transistor.

23. The device as claimed in claim 21 wherein the second transistor comprises a npn type transistor.

24. The device as claimed in claim 22 wherein the base of the second transistor is substantially within the range of 0.0005 mm to 0.05 mm.

25. The device as claimed in claim 23 wherein the base of the second transistor is substantially within the range of 0.0005 mm to 0.05 mm.

26. A silicon controlled rectifier device comprising:

a lightly doped region of a first conductivity type;

a lightly doped region of a second conductivity type adjacent said lightly doped region of said first conductivity type;

a heavily doped region of said first conductivity type adjacent said lightly doped region of said second conductivity type wherein at least an intermediate portion of said lightly doped region of said second conductivity type is between said heavily doped region of said first conductivity type and said lightly doped region of said first conductivity type;

a heavily doped region of said second conductivity type adjacent said lightly doped region of said first conductivity type wherein at least an intermediate portion of said lightly doped region of said first conductivity type is between said heavily doped region of said second conductivity type and said lightly doped region of said second conductivity type;

an avalanche junction formed at the interface of the lightly doped regions; and, wherein a reach-through effect across at least one of said intermediate portions of said lightly doped regions occurs prior to an avalanche junction breakdown across the avalanche junction when voltage is impressed across the heavily doped regions.

27. A silicon controlled rectifier device as claimed in claim 26 wherein the device is a lateral device.

28. A silicon controlled rectifier device as claimed in claim 26 wherein the device is a layered device.

29. The device as claimed in claim 26 wherein the at least one of said intermediate portions of said lightly doped regions comprises an n-type material.

30. The device as claimed in claim 26 wherein the at least one of said intermediate portions of said lightly doped regions comprises an p-type material.

31. The device as claimed in claim 27 wherein said lightly doped region of said first conductivity type comprises a p-type material substrate, said lightly doped region of said second conductivity type comprises an n-type material well disposed in said p-type material substrate, said heavily doped region of said first conductivity type comprises a p-type material region disposed in said n-type material well, and said heavily doped region of said second conductivity type comprises an n-type material region disposed in said said p-type material substrate.

32. The device as claimed in claim 27 wherein said lightly doped region of said first conductivity type comprises an n-type material substrate, said lightly doped region of said second conductivity type comprises a p-type material well disposed in said n-type material substrate, said heavily doped region of said first conductivity type comprises an n-type material region disposed in said p-type material well, and said heavily doped region of said second conductivity type comprises a p-type material region disposed in said said n-type material substrate.

33. The device as claimed in claim 31 wherein the reach-through effect across said at least one of said intermediate portions occurs across said lightly doped n-type material well.

34. The device as claimed in claim 33 wherein the reach-through effect occurs through a portion of said lightly doped n-type material well that is laterally oriented with respect to said p-type material region.

35. The device as claimed in claim 33 wherein the reach-through effect occurs through a portion of said lightly doped n-type material well that is vertically oriented with respect to said p-type material region.

35. The device as claimed in claim 31 wherein the reach-through effect across said at least one of said intermediate portions occurs across said lightly doped p-type material substrate.

36. The device as claimed in claim 32 wherein the reach-through effect across said at least one of said intermediate portions occurs across said lightly doped p-type material well.

37. The device as claimed in claim 36 wherein the reach-through effect occurs through a portion of said lightly doped p-type material well that is laterally oriented with respect to said n-type material region.

38. The device as claimed in claim 36 wherein the reach-through effect occurs through a portion of said lightly doped p-type material well that is vertically oriented with respect to said n-type material region.